OPERATORS MANUAL

RACAL-DANA

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5002

WIDEBAND LEVEL METER

RACAL-DANA

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FOR YOUR SAFETY

Before undertaking any maintenance procedure, whether it be a specific troubleshooting or maintenance procedure described herein or an exploratory procedure aimed at determining whether there has been a malfunction, read the applicable section of this manual and note carefully the WARNING and CAUTION notices contained therein.

The equipment described in this manual contains voltage hazardous to human life and safety and which is capable of inflicting personal injury. The cautionary and warning notes are included in this manual to alert operator and maintenance personnel to the electrical hazards and thus prevent personal injury and damage to equipment.

If this instrument is to be powered from the AC line (mains) through an autotransformer (such as a Variac or equivalent) ensure that the common connector is connected to the neutral (earthed pole) of the power supply.

Before operating the unit ensure that the protective conductor (green wire) is connected to the ground (earth) protective conductor of the power outlet. Do not defeat the protective feature of the third protective conductor in the power cord by using a two conductor extension cord or a three-prong/two-prong adaptor.

Maintenance and calibration procedures contained in this manual sometimes call for operation of the unit with power applied and protective covers removed. Read the procedures carefully and heed Warnings to avoid "live" circuit points to ensure your personal safety.

Before operating this instrument:

1. Ensure that the instrument is configured to operate on the voltage available at the power source. See Installation Section.

2. Ensure that the proper fuse is in place in the instrument for the power source on which the instrument is to be operated.

3. Ensure that all other devices connected to or in proximity to this instrument are properly grounded or connected to the protective third-wire earth ground.

If at any time the instrument:

- Fails to operate satisfactorily
- Shows visible damage
- Has been stored under unfavorable conditions
- Has sustained stress

It should not be used until its performance has been checked by qualified personnel.

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TOXIC HAZARD

LITHIUM BATTERIES

THIS EQUIPMENT CONTAINS LITHIUM BATTERIES

1. Lithium batteries are dangerous only if the case is broken. Breakage may occur due to internal pressure as well as the application of external force. The following precautions should be strictly observed:

   (1) Do not attempt to recharge the battery.

   (2) Do not short circuit the battery. Follow the instructions given regarding the order of terminal disconnection and reconnection when changing the battery.

   (3) Do not attempt to solder connections to the battery body. When soldering connections to the connecting strips, maintain the heat required for the minimum possible time.

   (4) Do not attempt to open the battery.

   (5) Do not dispose of discharged batteries in normal waste containers whose contents may be incinerated.

2. If exposure to fumes or material from a damaged battery occurs, medical treatment should be sought as soon as possible.

'POZIDRIV' SCREWS

The metric thread cross-head screws fitted to RACAL equipment are of the 'Pozidriv' type. Phillips and 'Pozidriv' screwdrivers are not interchangeable, and use of the wrong type of screwdriver may cause damage. POZIDRIV is a registered trade mark of G.K.N. Screws and Fasteners Ltd. 'Pozidriv' screwdrivers are manufactured by Stanley Tools Ltd.

MOS ELECTRONIC DEVICES

This unit contains MOS devices, and care should be taken to avoid static discharge damage.

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1.1 SPECIFICATION

1.1.1 The published specification for the Racal-Dana Wideband Level Meter Model 5002 is given in Table 1.1.

TABLE 1.1

Technical Specification

OPERATING MODES	
Measurement Functions:	The 5002 measures true r.m.s. voltage, mean voltage and positive or negative peak voltage. The measurements made may be displayed in voltage units, or converted, using a number of stored parameters, to provide a display of: (1) Average or peak power, in watts, computed from the measured voltage and a stored resistance value. (2) The ratio of the computed power to a stored power level. This displayed ratio may be numeric or expressed in dB. If the stored power level is 1 mW the computed power will be displayed in dBm. (3) The ratio of the measured voltage, r.m.s., peak or mean, to a stored voltage level. The ratio may be numeric or expressed in dB. If the stored voltage level and resistance value correspond to 1 mW, power ratios will be displayed in dBm. (4) The difference between the measured voltage and a stored voltage level. (5) The difference between the computed power and a stored power level. (6) The difference as in (4) expressed as a percentage of the stored voltage level. (7) The difference as in (5) expressed as a percentage of the stored power level.

TABLE 1.1 (Continued)

Technical Specification

ELECTRICAL CHARACTERISTICS	
Frequency Range:	DC and from 5 Hz to 20 MHz. For mean and peak measurements the frequency range is to 10 MHz.
Input Filter:	An internal single pole RC filter may be switched in to restrict the upper limit of the frequency range to 200 kHz (-3 dB).
Voltage Range:	Measuring r.m.s. voltage: 30 µV to 316 V Measuring peak or mean voltage: 1 mV to 316 V
Measurement Ranges:	The instrument has fourteen measurement ranges with full scale readings of: 100 µV 1 mV 1 V 316 µV 3.16 mV 3.16 V 10 mV 10 V 31.6 mV 31.6 V 100 mV 100 V 316 mV 316 V
Computed Power Range:	Using the limit values of stored resistance, True power range: 0.1 pW to 9 kW. Peak power range: 100 pW to 9 kW.
Input Resistance:	Approximately 1 MΩ.
Input Capacitance:	Approximately 40 pF on 1 V range and above. Approximately 65 pF on 316 mV range and below.
Maximum Permitted Input Levels:	The DC level plus peak AC level must not exceed 500 V on any range. The maximum r.m.s input must not exceed the values shown in Fig. 1.1.
Crest Factor:	The range of crest factor of the measured waveform over which the specified accuracy will be maintained is shown in Fig. 1.2.

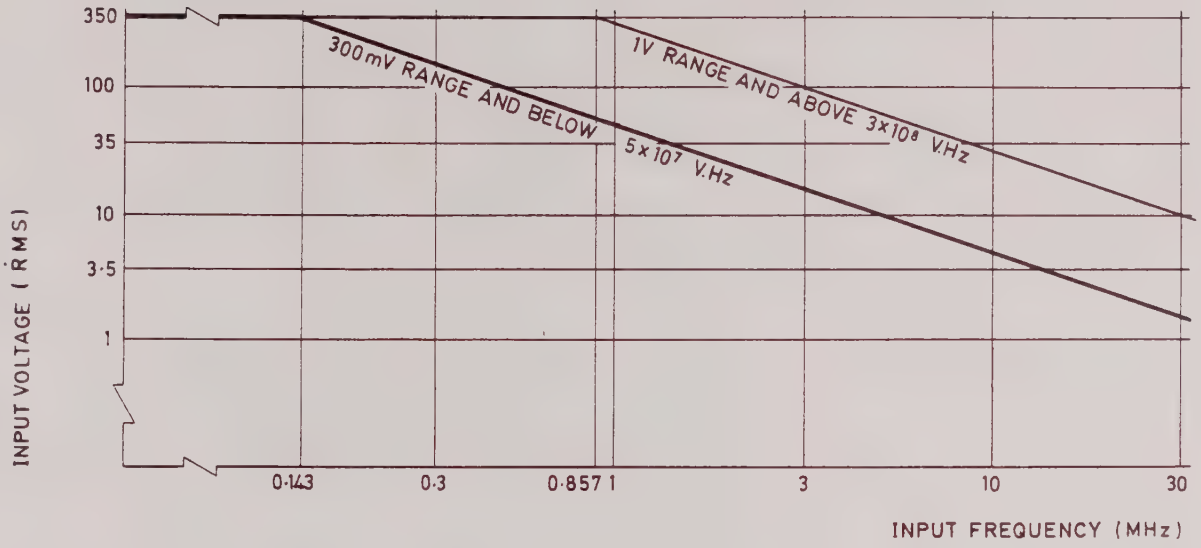


Fig. 1.1 Maximum RMS Input Levels

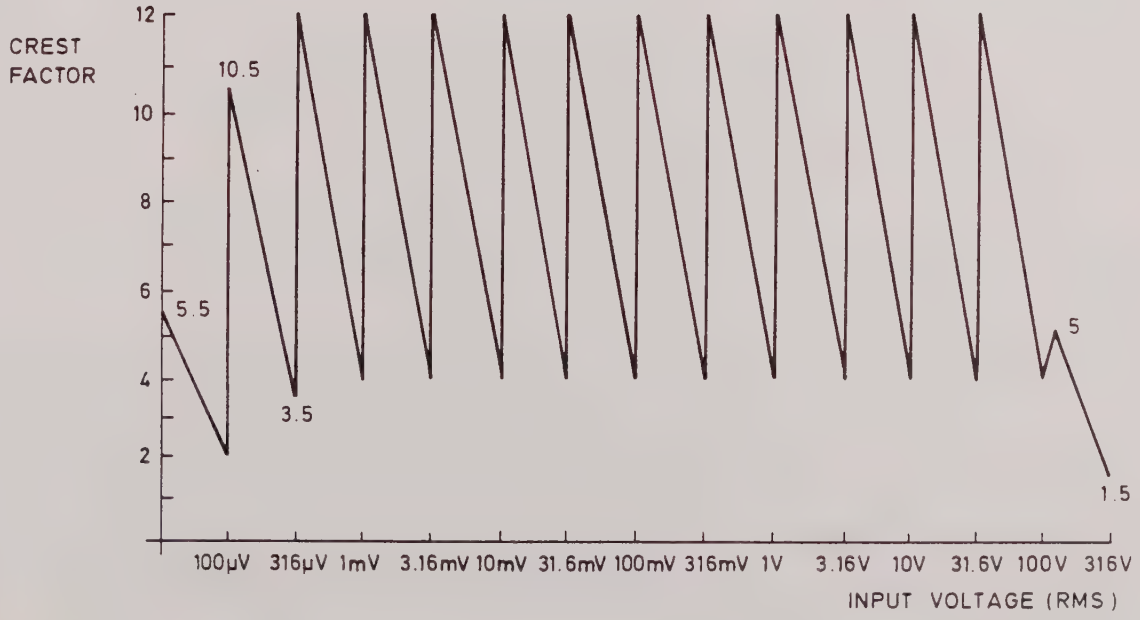


Fig. 1.2 Input Waveform Crest Factor Limits

TABLE 1.1 (Continued)

Technical Specification

ELECTRICAL CHARACTERISTICS (Continued)	
Voltage Measurement Accuracy:	The specified measurement accuracy for a sinusoidal input signal within the limits of 30% and 100% of the selected range, at an ambient temperature in the range from 18°C to 28°C, is ±0.5% of range ± (percentage of reading + zero error) as shown in Figs. 1.3, 1.4 and 1.5.
Digitising Error:	Add 0.1% of f.s.d. to the values given in Figs. 1.3, 1.4 and 1.5.
Temperature Coefficients:	When operating in the ambient temperature ranges from 0°C to 18°C and from 28°C to 55°C the following additional errors must be added to the figures obtained from Figs. 1.3, 1.4 and 1.5. AC measurement: ±0.04% per °C AC + DC measurement: ±0.1% per °C at 10 mV or above. Add a further ±10 µV per °C below 10 mV. DC measurement: ±0.1% per°C at 10 mV or above. Add a further ±10 µV per °C below 10 mV.
Power Measurement Accuracy:	Double the uncertainty for the equivalent voltage measurement.
Averaging Time:	The period between display updates, during which a number of measurements made are averaged, can be set in steps of 0.1 second between 0.1 second and 99.9 seconds (nominal). On switching on a value of 1 second is adopted automatically.
Analogue Settling Time:	The analogue settling time is 2 seconds. This is independent of the averaging time in use.

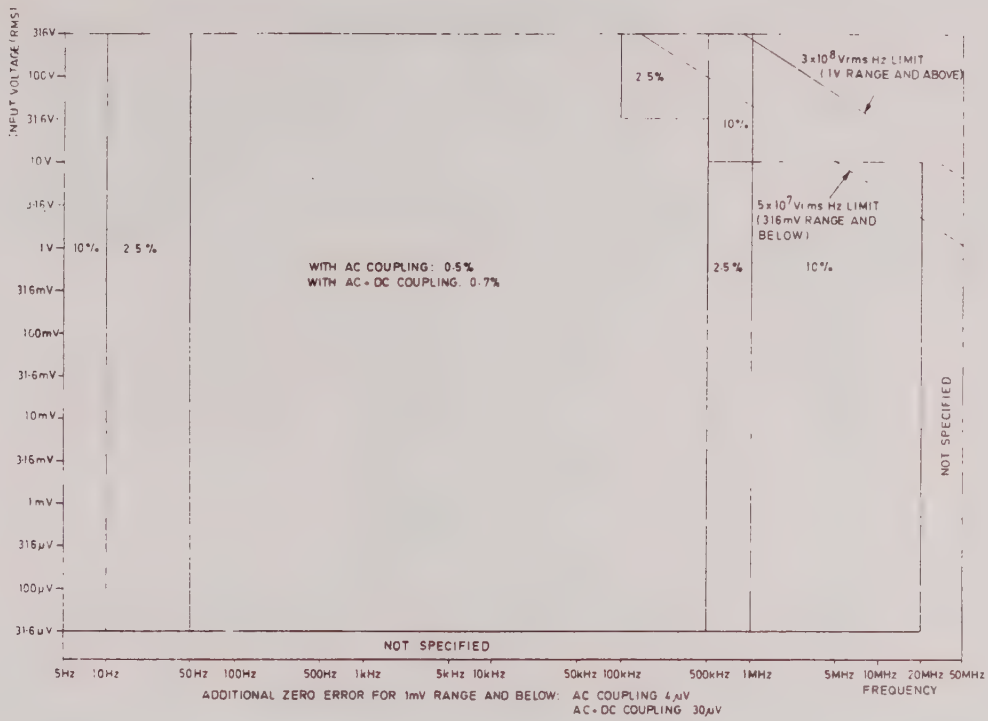


Fig. 1.3 Measurement Accuracy - R.M.S.

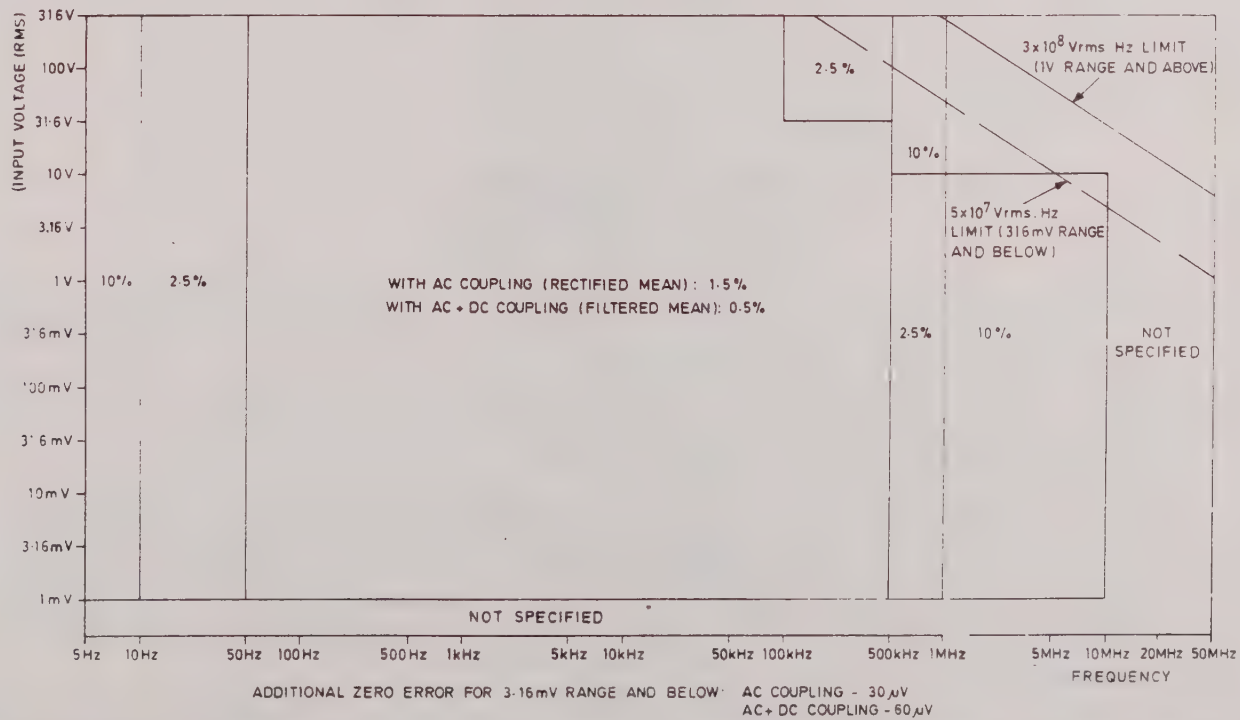


Fig. 1.4 Measurement Accuracy - Mean

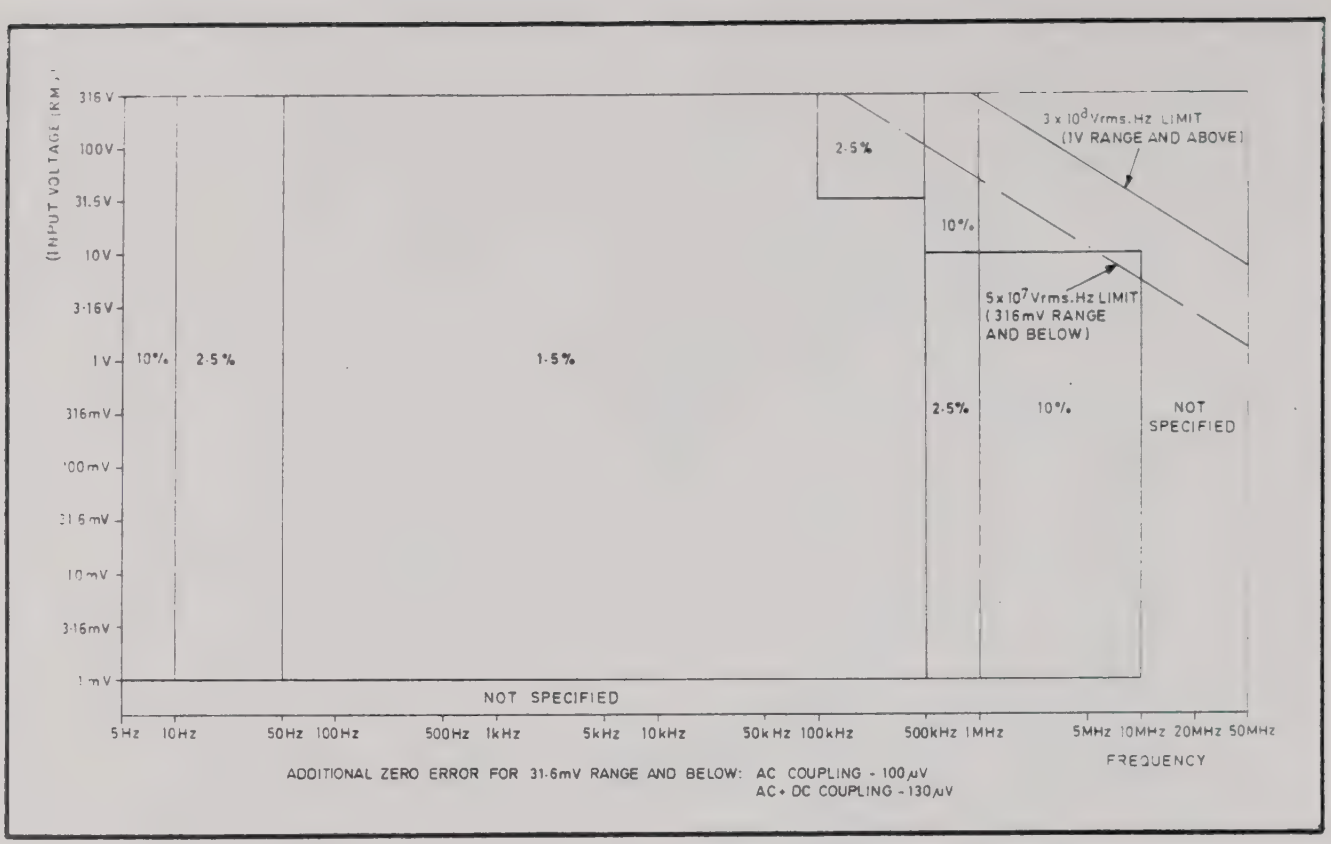


Fig. 1.5 Measurement Accuracy - Peak

TABLE 1.1 (Continued)

Technical Specification

ELECTRICAL CHARACTERISTICS (Continued)	
Input Connector:	A BNC connector is mounted on the front panel.
Input Isolation:	The input connector shell (common terminal) is isolated from chassis earth by a pair of back-to-back diodes. The permissible voltage difference is approximately 0.5 V. The maximum current between the common terminal and chassis earth must not exceed 5 A. A switch is provided to allow the common terminal to be held at chassis earth.

TABLE 1.1 (Continued)

Technical Specification

GPIB INTERFACE	
Function Subsets:	The interface operates in accordance with the following IEEE/IEC defined subsets:
	Source handshake SH1 Acceptor handshake AH1 Talker T5 Extended talker TE0 Listener L4 Extended listener LE0 Service request SR1 Remote local RL1 Parallel Poll PP0 Device Clear DC1 Device Trigger DT1 Controller C0
Interface Type:	The interface uses open collector drivers and is a type E1 interface as defined by IEEE standard 488.
Address Setting:	Five rear panel mounted switches allow the selection of any one of 31 pairs of addresses. Each pair consists of a talk and a listen address. The talk and listen addresses are distinguished by the logic levels on data lines DIO 6 and DIO 7. These logic levels are decoded by the 5002 without operator action. A sixth switch enables the 5002 to be put to the talk only mode.
Measurement Modes:	When addressed via the GPIB two measurement modes are available: (1) Continuous mode: The instrument performs continuous measurement cycles. The last measurement taken is put onto the bus when the instrument is put into the talk state. (2) Single mode: The instrument performs a single measurement cycle in response to a trigger command (which may be addressed or the GET command). The measurement taken is put onto the bus when the instrument is put into the talk state. The instrument can be set to generate a service request (SRQ) when the measurement is complete.

TABLE 1.1 (Continued)

Technical Specification

GPIB INTERFACE (Continued)	
	When in the talk only mode the instrument performs continuous measurement cycles in accordance with the front panel control settings. The last measurement made is put onto the bus in response to a signal on the NRFD control line.
Output Format:	The output data word consists of a string of twelve ASCII characters.
Optional Accessory:	Adaptor to convert to IEC 625-1 GPIB. Racal-Dana part number 23-3254

MECHANICAL CHARACTERISTICS	
Instrument Dimensions:	Height: 104 mm Width: 440 mm Depth: 403 mm
Instrument Weight:	Approximately 6.75 kg

POWER SUPPLIES	
Voltage:	A four range supply voltage selector is provided to accept 100 V, 115 V, 215 V or 230 V AC ±10%.
Frequency:	45 Hz to 440 Hz.
Power Consumption:	Approximately 40 VA.

TABLE 1.1 (Continued)

Technical Specification

ENVIRONMENTAL SPECIFICATION	
Operating Temperature:	$0^{o}C$ to $55^{o}C$
Storage Temperature:	$-40^{o}C$ to $+70^{o}C$.
Humidity:	95% RH at $+40^{o}C$.
Electromagnetic Compatability:	The instrument is designed to conform with TS 1400, Class A.

ACCESSORIES PROVIDED	
Power Lead:	Part Number 23-3227
Fuse for 90/127 V Operation:	Part Number 23-0022
Operator's Handbook:	

OPTIONAL ACCESSORIES	
19-inch Fixed Rack Mounting Kit:	Part Number 11-1496

REAR PANEL SIGNAL INPUT OPTION	
Availability:	A rear panel mounted signal input connector and isolation switch are available as a factory fitted option. These components replace the normal front panel mounted items.

2.1 INTRODUCTION

2.1.1 The Racal-Dana Wideband Level Meter Model 5002 is a light, portable, but extremely versatile, microprocessor controlled instrument. It permits measurements to be made with exceptional accuracy on waveforms having high crest factors. Special automatic zeroing and noise cancelling circuits permit measurements to be made over a range of signal amplitudes extending from 316 V r.m.s. down to 30 µV r.m.s. The instrument has an auto ranging facility, but provision is made for manual range selection.

2.1.2 Measurements may be made on DC signals, on AC signals in the frequency range from 5 Hz to 20 MHz and on signals having both DC and AC components. A low pass filter can be switched in to restrict the operating bandwidth to 200 kHz (-3dB).

2.1.3 The instrument measures true r.m.s., mean, positive peak or negative peak voltages of the applied signal. Operator set values of resistance, voltage and power may be stored in the instrument, and, in addition to display of the measured value in voltage units, displays of the following computed values can be obtained:

(a) Average or peak power, computed from V^2/R.

(b) The ratio of the computed power to the stored power level.

(c) The ratio of the measured voltage to the stored voltage level.

(d) The difference between the measured and stored voltage levels.

(e) The difference between the computed and stored power levels.

(f) The difference as in (d) expressed as a percentage of the stored voltage level.

(g) The difference as in (e) expressed as a percentage of the stored power level.

The instrument will also compute, and display, mean value scaled to r.m.s., peak-to-peak value, form factor and crest factor.

2.1.4 The input common line is isolated from chassis earth by back-to-back diodes, which permit a voltage difference of ±0.5 V. The common line can be connected to chassis earth, if required, by means of an isolation over-ride switch.

2.1.5 The instrument features a large, four digit, liquid crystal display (LCD). Coarse and fine LCD bar and dot displays form part of the display, and provide a pseudo-analogue form of indication. Units annunciators, GPIB status indicators and instrument status indicators are also incorporated.

2.2 CREST FACTOR

2.2.1 The maximum permitted crest factor on any range increases in inverse proportion to the displayed measurement. Errors will arise if the measured waveform has a significant proportion of its energy in harmonics which lie outside the instrument's measurement bandwidth.

2.3 OPERATING PRINCIPLES

2.3.1 Following a common input attenuator the instrument has separate AC and DC measurement channels. The AC channel features separate detectors for r.m.s., mean, positive peak and negative peak measurements, so that these waveform parameters are all measured simultaneously.

2.3.2 The detector outputs are connected in turn to an analogue to digital converter. The microprocessor scans the converter output every 0.1 second, reading each detector output in turn. One detector output, determined by the measurement function selected, is either converted directly to a display drive signal or processed, together with the contents of various internal stores, to provide power, difference or percentage difference display signals.

2.4 REDUCTION OF DISPLAY JITTER

2.4.1 The instrument has a variable averaging time, which may be set by the operator to ensure minimum jitter of the measurement indication when measurements are made on waveforms of high crest factor. The period over which measurements are averaged may be varied in steps of 0.1 second between 0.1 second and 99.9 seconds (nominal).

2.4.2 The display updating rate is set by the averaging time in use. To avoid the necessity for unacceptably low updating rates, continuous averaging of the measurements can be introduced by means of a special function. In this mode the display is updated every 0.1 second, the new displayed value being formed by adding N% of the current displayed value to (100-N%) of the new measurement. The effect of this is similar to filtering successive measurements in a single pole RC filter. The value of N is related to the time constant of the effective filter, which can be set by the operator.

2.5 STORAGE OF FRONT PANEL SETTINGS

2.5.1 Provision is made for the storage of up to twelve complete sets of front panel control settings, including the values set in the computed function stores, in a non-volatile memory. Each setting is allocated a number, and is retrieved and set by recalling that number. The front panel control settings in use when the instrument is switched off are automatically stored, and may be recalled when the instrument is switched on again.

2.6 CALIBRATION TO AN EXTERNAL SOURCE

2.6.1 The instrument display may be set to a reference value, when measurements are made on a reference signal source, by means of an operator selected calibration factor. The calibration factor, which is a divisor, is stored in the instrument, and may be enabled and disabled as required when making measurements on other signal sources.

2.7 GPIB INTERFACE

2.7.1 An internally mounted interface board permits the instrument to be controlled from, and communicate with, the IEEE 488 GPIB. The instrument may be used in the addressed mode or in the talk only mode. An adaptor to permit use with the IEC 625-1 GPIB is also available.

2.8 MAINTENANCE

2.8.1 It is recommended that customers should take advantage of the servicing and calibration service offered by Racal-Dana Instruments Ltd., and their agents. For customers wishing to carry out their own servicing, a comprehensive Maintenance Manual is available from Racal-Dana Instruments Ltd. When ordering a manual, the serial number of the instrument for which the manual is required should be quoted.

3.1 INTRODUCTION

3.1.1 This section contains instructions concerning all tasks which must be performed before taking the 5002 into use for the first time, or when the instrument is used at a new location. It includes instructions for mounting the equipment in an equipment rack, if this is required, and for preparing the instrument for connection to a GPIB controlled system.

3.2 POWER SUPPLY

3.2.1 AC VOLTAGE RANGE SETTING

3.2.1.1 The supply voltage setting is varied by changing the position of a small drum, located under a hinged cover beside the input plug. The setting in use can be seen through a window in the cover.

3.2.1.2 If it is necessary to change the voltage setting, proceed as follows:

(a) Switch off the AC supply and remove the line power socket.

(b) Using a 1/4 in (5mm) flat-bladed screwdriver, prise open the hinged cover.

(c) Remove the voltage setting drum.

(d) Withdraw the fuse carrier by pulling the end, marked with an arrow, straight out of the aperture.

(e) Ensure that the fuse fitted is suitable for the voltage range to be used.

(f) Replace the fuse and carrier. Ensure that the arrow on the fuse carrier points in the same direction as those on the underside of the cover.

(g) Replace the voltage setting drum so that the required setting is outermost.

(h) Close the hinged cover and ensure that the required setting is visible in the window.

(j) Replace the line power socket.

3.2.2 LINE FUSE

3.2.2.1 Check that the line fuse rating is correct for the local AC supply voltage. The fuse is a 5 mm x 20 mm in glass cartridge, surge resisting type. The Racal-Dana part numbers for replacement fuses are:-

90 V to 127 V supply	500 mAT	23-0022
193 V to 253 V supply	250 mAT	23-0031

3.2.3 DC FUSE

3.2.3.1 Check that the DC fuse fitted to printed circuit board 19-1024 is serviceable, and of the correct rating. The fuse should be a 1.6 A, surge resisting, ¼ in x 1¼ in glass cartridge type, Racal-Dana part number 23-0055. Instructions for the removal and replacement of the covers are given in paragraph 3.4.

3.2.4 POWER LEAD

3.2.4.1 The power lead must be fitted with a suitable connector in accordance with the standard colour code.

	European	American
Live	Brown	Black
Neutral	Blue	White
Earth (Ground)	Green/Yellow	Green

3.3 FITTING THE FIXED RACK MOUNTING KIT 11-1496

3.3.1 The kit contains a pair of mounting brackets and four screws. The method of fitting the kit is shown in Fig. 3.1. The fitting procedure is as follows:

(a) Switch off the instrument and the AC supply. Remove the line power socket.

(b) Stand the instrument upside down on a bench, and remove the two screws from each of the plastic mouldings at the rear corners of the instrument. Remove the mouldings.

(c) Slide the bottom cover towards the rear of the instrument by about 1 inch, and lift the cover off.

(d) Remove the bench feet from the bottom cover by removing the retaining screw from each foot. Replace the bottom cover.

(e) Remove the side trim panels by sliding them to the rear of the instrument. Replace and secure the plastic mouldings removed in (b).

(f) Remove the two screws securing the handle at one side of the instrument. Do not remove the handle.

(g) Position a bracket from the kit at the side of the instrument, so that the two holes in a flange are positioned over the holes for the handle securing screws.

(h) Secure the handle and bracket, using two of the countersunk headed screws from the kit.

(j) Repeat (f) to (h) at the other side of the instrument.

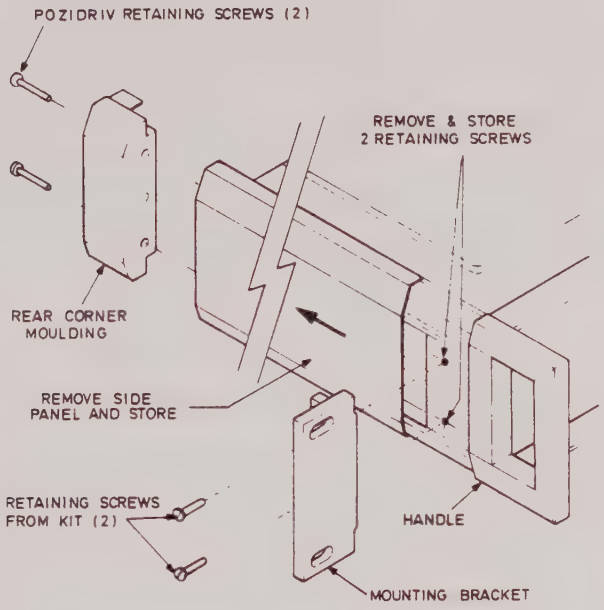


Fig. 3.1 Fitting the Fixed Rack Mounting Kit 11-1496

3.4 REMOVAL AND REPLACEMENT OF THE COVERS

WARNING: DANGEROUS AC VOLTAGE LEVELS ARE EXPOSED WHEN THE COVERS ARE REMOVED WITH THE AC SUPPLY CONNECTED

3.4.1 (a) Switch off the instrument and the AC supply. Remove the line power socket.

(b) Stand the instrument on its front handles, and remove the two screws from each of the plastic mouldings at the rear corners of the instrument. Remove the mouldings.

(c) The covers can now be removed by sliding them towards the rear of the instrument. Note that the removal of the plastic mouldings also releases the side trim panels, which should either be removed or secured by replacement of the mouldings.

(d) The covers are replaced in the reverse manner. Note that the straight, unfolded edge of the cover fits to the front of the instrument, and locates in a groove in the rear face of the front panel. The rear edge of the cover is folded under, and locates in a groove in the rear panel.

3.5 PREPARATION FOR USE WITH THE GPIB

3.5.1 INTERFACE CONNECTOR

3.5.1.1 Connection to the GPIB is made via an IEEE 488 standard connector. The pin assignment is given in Table 3.1. An adaptor, Racal-Dana part number 23-3254, to convert the connector to the IEC 625-1 standard is available as an optional accessory.

TABLE 3.1

GPIB Connector Pin Assignment

Pin	Signal Line	Pin	Signal Line
1	DIO 1	13	DIO 5
2	DIO 2	14	DIO 6
3	DIO 3	15	DIO 7
4	DIO 4	16	DIO 8
5	EOI	17	REN
6	DAV	18	Gnd.(6)
7	NRFD	19	Gnd.(7)
8	NDAC	20	Gnd.(8)
9	IFC	21	Gnd.(9)
10	SRQ	22	Gnd.(10)
11	ATN	23	Gnd.(11)
12	SHIELD	24	Gnd.(5 and 17)

3.5.2 ADDRESS SETTING

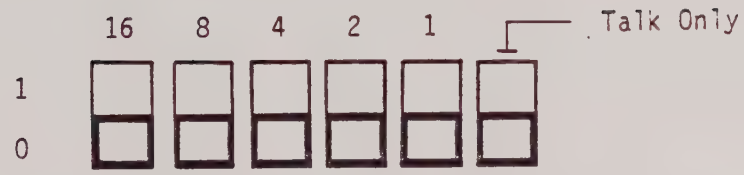
3.5.2.1 The interface address is set on five rear panel mounted switches. The right hand switch, as viewed from the rear of the instrument, is for bit 1, the least significant address bit. The permitted address settings, in decimal and ASCII character form, are given in Table 3.2. The instrument is despatched with the address switches set to ASCII , (listen) and ASCII L (talk). The address set, in decimal format, can be displayed by pressing

/RECALL//SHIFT//LOCAL/.

3.5.2.2 The sixth switch, when put to the logic '1' position, puts the interface into the talk only mode. With the switch in this position the settings of the first five switches are irrelevant.

TABLE 3.2

Address Switch Settings



SWITCH SETTINGS					ADDRESS CODES		
16	8	4	2	1	DECIMAL	ASCII LISTEN ADDRESS	ASCII TALK ADDRESS
0	0	0	0	0	0	SP	@
0	0	0	0	1	1	!	A
0	0	0	1	0	2	"	B
0	0	0	1	1	3	#	C
0	0	1	0	0	4	$	D
0	0	1	0	1	5	%	E
0	0	1	1	0	6	&	F
0	0	1	1	1	7	'	G
0	1	0	0	0	8	(	H
0	1	0	0	1	9	)	I
0	1	0	1	0	10	*	J
0	1	0	1	1	11	+	K
0	1	1	0	0	12	,	L
0	1	1	0	1	13	-	M
0	1	1	1	0	14	.	N
0	1	1	1	1	15	/	O
1	0	0	0	0	16	Ø	P
1	0	0	0	1	17	1	Q
1	0	0	1	0	18	2	R
1	0	0	1	1	19	3	S
1	0	1	0	0	20	4	T
1	0	1	0	1	21	5	U
1	0	1	1	0	22	6	V
1	0	1	1	1	23	7	W
1	1	0	0	0	24	8	X
1	1	0	0	1	25	9	Y
1	1	0	1	0	26	:	Z
1	1	0	1	1	27	;	[
1	1	1	0	0	28	<	\
1	1	1	0	1	29	=	]
1	1	1	1	0	30	>	^

Instrument despatched with this setting

4.1 INTRODUCTION

4.1.1 The first part of this section contains instructions for operating the 5002 using the front panel controls. This information is given in two forms. The purpose of each control is given in paragraph 4.2. This is followed by specific instructions on how to set the instrument to make particular types of measurement.

4.1.2 Information regarding the control of the instrument using the GPIB is given, commencing at paragraph 4.22. It is essential that the operation of the instrument using the front panel controls is understood before operation using the GPIB is attempted.

4.2 DESCRIPTION OF CONTROLS, INDICATORS AND CONNECTORS

4.2.1 Each group of controls or connectors described is numbered to correspond with the indicators on Fig. 4.1 (front panel) or Fig. 4.2 (rear panel).

4.2.2 FRONT PANEL ITEMS

(1) Display: A custom built liquid crystal display is used. It incorporates the following indicators:

(a) Four digit alpha-numeric display.
This display, with decimal point and sign indicator, is used primarily to indicate the value of the measured quantity. It may also be used to display the values held in the instrument's internal stores, or to indicate certain types of error.

(b) Units annunciators.
These indicate the units of the measurement being displayed.

(c) Compute function indicators.
These indicate when the measurement functions requiring computation by the microprocessor (ratio, % difference, difference (null) or dB) are in use.

(d) CF indicator.
This provides an indication that one of the special functions for crest factor computation is enabled.

(e) FF indicator.
This indicates that the form factor of the input waveform is being displayed.

(f) SF Indicator.
This indicates that a special function other than crest factor or form factor has been selected.

(g) GPIB indicators.
These indicate whether the instrument is under remote or local control, whether it is talking or listening and whether it is generating a service request.

(h) Analogue display.
This is a two part, coarse and fine, LCD bar and dot display. The upper, coarse, section has ten segments and indicates the measured value to within -0%, +10% of full scale. The lower, fine, section also has ten dots, representing sub divisions of the coarse section. The overall indication is therefore within -0% and +1% of full scale. The coarse section of the display is enabled automatically when manual range selection is in use. The complete display may be enabled by pressing /METER//METER/

(2) Range Control Keys: /MANUAL/
This key selects the auto-ranging and manual ranging modes on alternate operations. The appropriate indicator will light to show the mode in use. On switching from auto to manual no change of range will take place.

/STEP UP/ and /STEP DOWN/
These keys permit the next range above or below the one in use to be selected when in the manual ranging mode. If these keys are operated when the instrument is in the auto-ranging mode, the manual ranging mode will be selected and the appropriate change of range will occur.

(3) METER Key: This switches the analogue display on and off on successive operations. The coarse part of the analogue display is switched on automatically when the manual ranging mode is selected. It will be switched off by the first operation of the METER key, subsequent operations of the key controlling the complete analogue display.

(4) Primary Measuring Function Keys: These keys allow the measured or computed value to be displayed in voltage or power units. The appropriate indicator will light to show which function is in use.

The instrument measures voltage. When display in power units is demanded, the measured voltage is converted using the resistance value stored in the Ω store.

(5) Secondary Measuring Function Keys:

These keys select which of the AC measuring system detector outputs is displayed or used to produce a computed function display. The selection of a secondary measuring function cancels any secondary measuring function previously selected.

(6) Computed Measuring Function Keys:

These keys allow one of the four computed measuring functions to be selected. The appropriate indicator will light to show the function selected.

If the Voltage primary measuring function is in use the computations for all four functions will be performed in voltage units. If the Watts primary measuring function is in use the computations for the ratio, % difference and difference (null) functions will be performed in power units. The resistance value stored in the Ω store is used in the conversion from voltage to power units. The computation for the dB function is always performed in voltage units. The keys also act as the address keys for the computed function stores. The LED adjacent to the appropriate key will light when a stored value is recalled.

(7) CAL FACTOR and FILTER Key:

The key is used without /SHIFT/ for the following purposes:

(a) Successive operations will enable and disable the operator selected scaling factor. The indicator will light when the factor is enabled.

(b) The sequence /RECALL//CAL FACTOR/ will result in the display showing the current value held in the scaling factor store. The RECALL and CAL FACTOR indicators will both light when the scaling factor is recalled and displayed.

(c) The sequence /STORE//CAL FACTOR/ will store the number shown on the display in the scaling factor store. (The number displayed will have been set by means of the numeric keys or by ratio measurement).

When used with /SHIFT/ the key switches a single pole RC low pass filter into or out of the signal measurement path. The filter restricts the upper limit of the frequency range to 200 kHz (-3dB). The indicator lights when the filter is in circuit.

(8) Input Coupling Key: Successive operations of this key select AC or AC + DC coupling at the signal input. Indicators are provided to show the form of coupling in use.

(9) SHIFT Key: Pressing this key results in the next key pressed performing its shifted function. The shift operation affects the next key operation only, and cannot be continuously set.

(10) STORE Key: This key is used, in conjunction with a store address key, to enter values in the instrument's internal stores. The instrument returns to the measurement mode when storage is completed. The indicator lights when the key is pressed, and is extinguished when storage is completed.

(11) RECALL Key: This key is used, in conjunction with a store address key, to recall values from the instrument's internal stores. The use of the key stops the instrument measuring, so that the recalled information can be shown on the display, except in the case of recall of complete front panel settings. In this case the instrument returns to the measurement mode, with the recalled values set, as soon as the recall action is completed.

The indicator lights when the key is pressed, and is extinguished when the instrument returns to the measurement mode, or when a new value is entered into store.

(12) CONTINUE Key: Operation of this key returns the instrument to the measurement mode following the display of the contents of the instrument's internal stores.

(13) Numeric Keypad: These keys, used without /SHIFT/, provide the means of setting, on the display, values to be entered in the instrument's internal stores. Entries may be signed negative, using the +/- key to allow comparison with negative peak readings. The +/- key is used AFTER the required numeric entry and the entry of the appropriate units has been made.

The keys are used, with /SHIFT/, to add units annunciators to values to be stored, to address the Ω and AVERAGE stores, to display the full scale deflection value of the measurement range in use and to select the special functions (SF). Pressing /SHIFT//LOCAL/ will return the instrument to local control from remote control via the GPIB except when the instrument is in the remote control with lockout state (RWLS).

Pressing /RECALL//SHIFT//LOCAL/ will result in the current GPIB address, in decimal format, being displayed.

(14) INPUT Connector: The signal to be measured is connected to this BNC connector. The instrument can be supplied with the connector in an alternative position on the rear panel.

(15) ISOLATE Switch This switch is open in the ISOLATE position, when the INPUT connector shell (common terminal) is isolated from chassis earth.

When the switch is closed the common terminal is connected to chassis earth.

(16) LINE Switch This switch controls the AC supply to the instrument power supply circuit. The indicator lights when the instrument is switched on.

4.2.3 REAR PANEL ITEMS

(17) INPUT Connector and ISOLATE Switch: The instrument can be supplied with these components mounted on the rear panel as an alternative to front panel mounting.

(18) GPIB Socket: This socket is wired for direct connection to the IEEE 488 bus. An adaptor to permit the instrument to be used with the IEC 625-1 bus is available as an optional accessory.

(19) Address Switches: The five left hand switches allow one of 31 Listen/Talk address pairs to be selected. Putting a switch to the up position represents a logic '1'. The right hand switch represents the least significant bit (bit 1, on DIO 1).
The sixth switch, when put to the up position, selects the talk only mode. The setting of the remaining address switches is then irrelevant.

(20) Supply Voltage Range Selector: This allows the selection of one of four line voltage ranges. The range selected can be read on the selecting plate through the clear plastic cover.

(21) Line Fuse: The fuse is a 5mm x 20mm glass cartridge pattern, and should be of the surge resisting type.

(22) Line Power Plug: The power input plug incorporates a filter, and external supply filtering should be unnecessary.

4.3 SWITCHING ON

4.3.1 The equipment should be prepared for use in accordance with the instructions given in Section 3. If the instrument is being used for the first time, or at a new location, pay particular attention to the setting of the supply voltage range selector.

4.3.2 Connect the instrument to the AC supply, and set the LINE switch to ON. Check that the LINE indicator lights.

4.3.3 The front panel indicators will show:

(a) AUTO mode

(b) VOLTS primary measurement function selected

(c) RMS secondary measurement function selected

(d) AC coupling selected

The display will show 5002 for approximately one second. If no input signal is connected the display will then show the error code for under range signal, Ur.

4.4 INPUT ISOLATION

4.4.1 The instrument may be operated with the input common terminal isolated from chassis earth by putting the ISOLATE switch to ISOLATE. The permissible voltage difference is ±0.5 V.

4.5 SETTING OF AVERAGING TIME

4.5.1 When the equipment is first switched on the averaging time, which sets the display updating rate, is set to 1 second. This can be reset to provide a higher updating rate, or to give a lower updating rate with less jitter. The range of averaging times is from 0.1 second to 99.9 seconds in steps of 0.1 second. Irrespective of the averaging time used, a settling time of two seconds must be allowed after applying the measured signal before the specified accuracy is achieved.

4.5.2 The averaging time set can be displayed by pressing

/RECALL//SHIFT//AVERAGE/.

The RECALL indicator will light to indicate that a stored value is being displayed. If no change to the averaging time is required, press

/CONTINUE/.

The RECALL indicator will be extinguished and the instrument will return to the measurement mode.

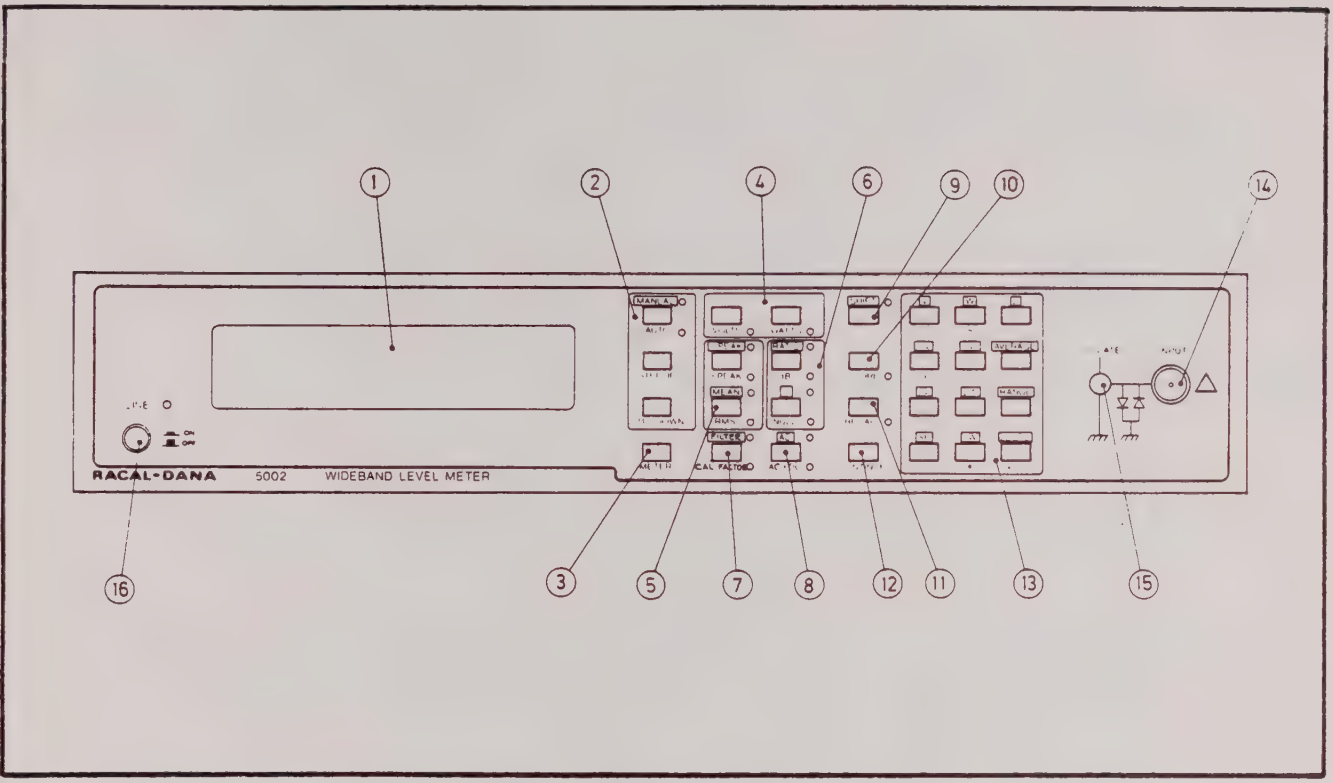


Fig. 4.1 Front Panel

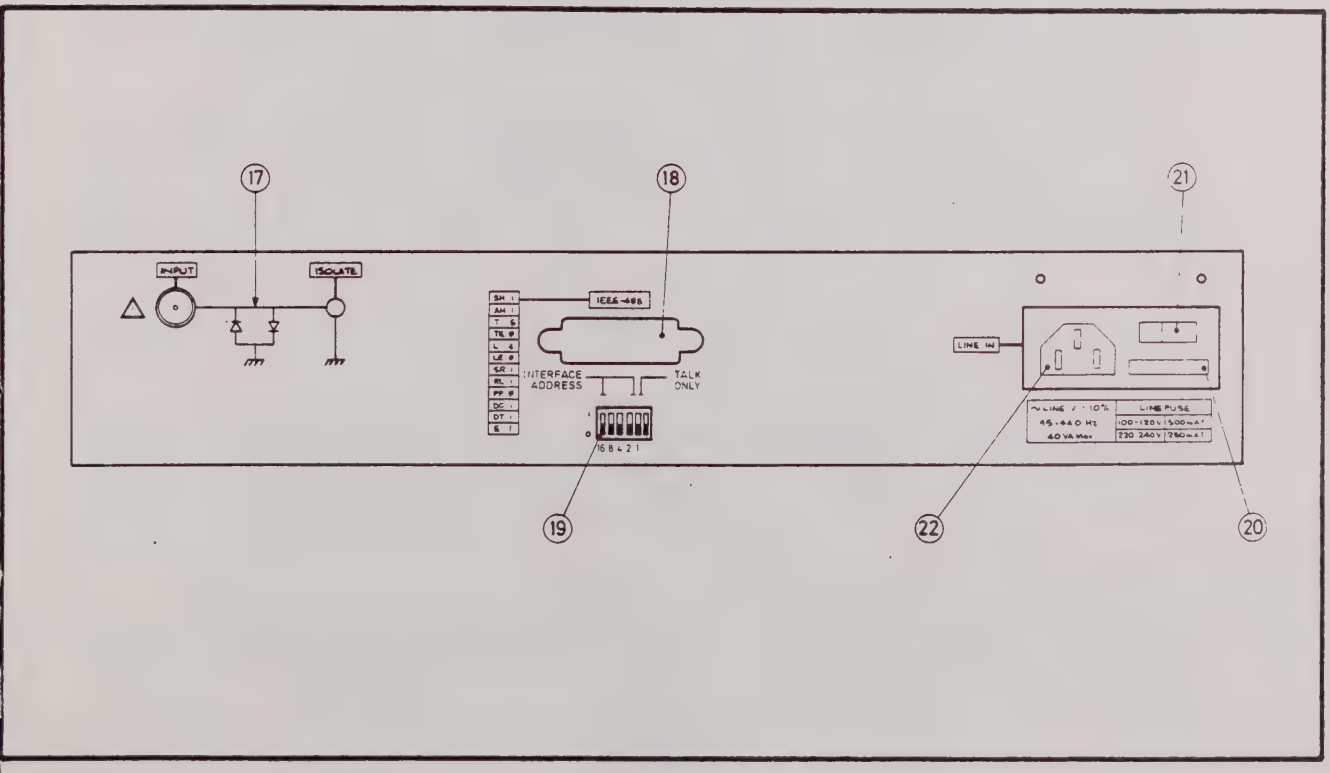


Fig. 4.2 Rear Panel

4.5.3 If the averaging time is to be reset, set the required value on the display, using the numeric keys. The RECALL indicator will be extinguished when the first numeric key is pressed. When the required averaging time is correctly set, press

/STORE//SHIFT//AVERAGE/.

The STORE indicator will light when the key is pressed. It will be extinguished, and the instrument will return to the measurement mode, when the storage of the new value is complete.

4.5.4 At any time up to the point where

/AVERAGE/

is pressed, the procedure can be aborted by pressing

/CONTINUE/.

The instrument will return to the measurement mode with the averaging time unchanged.

4.6 CONTINUOUS AVERAGING MODE

4.6.1 The use of this mode avoids the low display updating rates which are caused by the use of long averaging times. The display is updated every 0.1 second to a value obtained partly from the current displayed value and partly from the new measured value. The overall effect is similar to that which would be obtained if successive measured values were filtered in a single pole RC filter.

4.6.2 The mode is enabled and disabled using SPECIAL FUNCTIONS 60.1 and 0 (see paragraph 4.20). The mode will be disabled automatically if +PEAK or -PEAK is selected as the secondary measurement function, but, if the special function is not cancelled, will be re-enabled when RMS or MEAN is subsequently selected.

4.6.3 The time constant of the effective filter will be the value set in the AVERAGE store. This value may be viewed, and, if required, changed, using the procedure given in paragraph 4.5.

4.6.4 The mode is automatically disabled during any measurement cycle in which the current displayed value and the new measured value differ by more than 5%. This results in a rapid change of the displayed value in response to large step changes of input level.

4.7 INPUT FILTER

4.7.1 An input filter, which restricts the upper limit of the frequency range to 200 kHz (-3dB), may be inserted into and removed from the measured signal path by successive operations of

/SHIFT//FILTER/.

The FILTER indicator lights when the filter is in circuit.

4.8 RANGING MODE SETTING

4.8.1 On switching on, the instrument will be set to the auto-ranging mode. To put the instrument into the manual ranging mode without changing the range in use, press the AUTO/MANUAL key. This key selects manual ranging and auto-ranging on successive operations. The indicator for the mode in use will light. The instrument may be switched from the auto-ranging mode to the manual ranging mode, accompanied by a change to an adjacent range, by means of the STEP UP or STEP DOWN key. When manual ranging is selected an analogue indication of the measured signal as a fraction of full scale appears in the display.

4.8.2 When in the manual ranging mode the range in use may be changed by pressing

/STEP UP/ or /STEP DOWN/.

The full scale value for the range in use can be displayed by pressing

/RECALL//SHIFT//RANGE/.

The RECALL indicator will light when the key is pressed. To return the instrument to the measurement mode, press

/CONTINUE/.

4.8.3 If the input signal is outside the limits of 31.6% and 114.9% of full scale of the range in use, the display will alternate between the measured value and an under-range or over-range error indication. When in the auto-ranging mode a range change will occur if the input signal is outside the limits of 31.7% and 114.9% of full scale, so that error indications are obtained on the highest and lowest ranges only.

4.9 VOLTAGE PRIMARY MEASUREMENT FUNCTION

4.9.1 When first switched on the instrument will be set to the voltage measuring function. If the instrument has been in use and is set for some other measuring function, press

/VOLTS/.

The VOLTS indicator will light. No change to the secondary measurement functions selected will occur, but any computed function selected will be cancelled.

4.10 POWER PRIMARY MEASUREMENT FUNCTION

4.10.1 The 5002 measures in voltage units, but can convert measurements made into power units by squaring the measured voltage and dividing by the resistance value held in the Ω store. To select the power measuring function, press

/WATTS/.

The WATTS indicator will light. No change to the secondary measurement functions selected will occur, but any computed function selected will be cancelled.

4.10.2 The value in the Ω store will be set to 600 Ω on switching on. The number in the store can be displayed by pressing

/RECALL//SHIFT//Ω/.

The RECALL indicator will light when the key is pressed to show that a stored value is being displayed.

4.10.3 If no change to the resistance value is required, press

/CONTINUE/.

The RECALL indicator will be extinguished, and the instrument will return to the measurement mode. If the resistance value is to be changed, set the required value on the display, using the numeric keys, followed by

/SHIFT//Ω/.

The RECALL indicator will be extinguished when the first numeric key is pressed. When the required resistance value is set, press

/STORE//SHIFT//Ω/.

The STORE indicator will light when the key is pressed. It will be extinguished, and the instrument will return to the measurement mode, when the storage of the new value is complete.

4.10.4 At any time up to the point where

/Ω/

is pressed, the procedure can be aborted by pressing

/CONTINUE/.

The instrument will return to the measurement mode with the resistance value unchanged.

NOTE: The values held in the %, RATIO, NULL and dB stores are in voltage units. The values may have been computed from keybord inputs or displayed power measurements, using the resistance value in the Ω store at the time of entry. These values are NOT automatically updated when the resistance value in the Ω store is changed.

4.11 SECONDARY MEASUREMENT FUNCTION SELECTION

4.11.1 The r.m.s., mean, positive peak and negative peak detectors in the AC measuring system operate simultaneously. The r.m.s. detector is selected when the instrument is first switched on. To select a different detector operate the appropriate secondary measurement function key.

4.11.2 Each of the secondary measurement function keys toggles between the two functions associated with it. When changing from the function controlled by one key to those controlled by the other, the function having the legend above the key may be obtained either by making use of the SHIFT key or by operating the secondary function key twice.

4.11.3 The output of the DC detector is added to that of the selected AC detector when AC + DC coupling is selected. The following points should be noted:

(a) With AC + DC coupling selected, use of the MEAN secondary measurement function will result in a display of the filtered mean, not the rectified mean, of the measured signal. A display of the rectified mean can be obtained by using SPECIAL FUNCTION 50.1 (see paragraph 4.20).

(b) With AC + DC coupling and MEAN secondary measuring function selected the instrument can be used for direct voltage measurements.

(c) If the measured waveform has a DC level more positive than the negative peak value of the AC component, the selection of AC + DC coupling and the -PEAK secondary measurement function will result in a display of the waveform trough value, which will be shown as having a positive polarity. Similarly, with a DC level more negative than the positive peak value of the AC component, use of AC + DC coupling and the +PEAK secondary measurement function will give a negative polarity display.

4.11.4 Three forms of peak measurement, applicable to both positive and negative peak measurements, are available. These are:

(a) True Peak Measurement

The selected peak detector output is sampled every 0.1 second throughout a measurement period equal to the value stored in the AVERAGE store. At the end of the measurement period the greatest detector output which has occurred is displayed.

(b) Averaged Peak Measurement

The selected peak detector output is sampled every 0.1 second throughout successive measurement periods equal to the value stored in the AVERAGE store. At the end of the measurement period the average of all the measured detector outputs is displayed.

(c) Peak Hold Measurement

The selected peak detector output is sampled every 0.1 second over a measurement period started and terminated by operations of /CONTINUE/. The display indicates the greatest detector output which has occurred during the current measurement period.

NOTE: (1) The first measurement period commences immediately this form of peak measurement is selected, and does not require operation of /CONTINUE/.

(2) When peak hold measurement is selected the manual ranging mode is automatically selected and the generation of error code 03 is inhibited.

(3) If error code 02 is generated the indication will be held on the display until /CONTINUE/ is pressed or the peak hold measurement mode is cancelled.

4.11.5 The true peak measurement function is selected automatically on switching on. The averaged peak measurement function and peak hold measurement function are enabled by means of SPECIAL FUNCTIONS 70.1 and 70.2 and disabled by means of SPECIAL FUNCTION 0 (see paragraph 4.20). The form of peak measurement selected is not automatically cancelled when RMS or MEAN is selected as the secondary measurement function, and will be returned to when the peak measurement function is re-selected.

4.12 COMPUTED FUNCTIONS

4.12.1 One of four computed measurement functions, ratio, percentage ratio, dB and null, may be selected by means of the computed function keys. The SHIFT key is used to obtain the function having its legend above the key. The operation of either primary measurement function key cancels any computed measurement function selected, so the required primary measurement function must be set before a computed function is selected. The computed function selected is not, however, affected by change of the secondary measurement function.

4.13 RATIO MEASUREMENTS

4.13.1 With the ratio function selected the instrument computes

$$\frac{\text{measured voltage}}{\text{voltage value held in RATIO store}}$$

To select the ratio function, press

/SHIFT//RATIO/.

The RATIO indicator will light. Note that the display will indicate a ratio of voltages or powers according to whether the voltage or power primary measuring function is selected. The conversion to power units uses the current resistance value in the Ω store. The measured voltage used in the computation may be r.m.s., mean, +peak or -peak, according to the secondary measuring function selected.

4.13.2 When the instrument is first switched on the RATIO store will be loaded with 1 volt. The value in the store can be displayed by pressing

/RECALL//SHIFT//RATIO/.

The RECALL indicator will light when the key is pressed to show that a stored value is being displayed. The displayed value will be in voltage or power units, according to the primary measuring function selected.

4.13.3 If no change to the stored level is required press

/CONTINUE/.

The RECALL indicator will be extinguished, and the instrument will return to the measurement mode.

4.13.4 If the stored value is to be reset to a specified figure, set the required value on the display using the numeric keys. The RECALL indicator will be extinguished when the first numeric key is pressed. The value set on the display may be in voltage or power units. When the required digits have been set, press

/SHIFT//APPROPRIATE UNITS//STORE//SHIFT//RATIO/.

The appropriate display annunciator will light when the units are entered. The STORE indicator will light when the key is pressed. It will be extinguished, and the instrument will return to the measurement mode, when the storage of the new value is complete.

4.13.5 The RATIO store may also be reset to the current displayed value when voltage or power measurements are being made. To reset the stored value to the current displayed value, press

/STORE//SHIFT//RATIO/.

The STORE indicator will light when the key is pressed, and will be extinguished when the storage of the new value is completed.

4.13.6 At any time up to the point where

/RATIO/

is pressed either store updating procedure can be aborted by pressing

/CONTINUE/.

4.14 PERCENTAGE DIFFERENCE MEASUREMENTS

4.14.1 With the percentage difference function selected the instrument computes

$$\frac{\text{measured voltage - voltage value in \% store}}{\text{voltage value in \% store}} \times 100$$

To select the percentage difference function, press

/SHIFT//%/.

The % indicator will light. Note that the display will indicate a percentage difference of voltages or powers according to whether the voltage or power measuring function is selected. The conversion to power units uses the current resistance value in the Ω store. The measured voltage used in the computation may be r.m.s., mean, +peak or -peak, according to the secondary measuring function selected.

4.14.2 When the instrument is first switched on the % store will be loaded with 1 volt. The value in the store can be displayed and, if necessary, changed using the same procedures as those described for the RATIO store. The keyboard address of the % store is

/SHIFT//%/.

4.15 NULL MEASUREMENTS

4.15.1 With the null function selected the instrument computes

measured voltage - voltage value in NULL store.

To select the null function, press

/NULL/.

The NULL indicator will light. The current displayed value will be entered into the NULL store, and the display will indicate zero. When the input level is changed the display will indicate a difference of voltages or powers, according to whether the voltage or power primary measuring function is selected. The conversion to power units uses the current resistance value in the Ω store. The measured voltage used in the computation may be r.m.s., mean, +peak or -peak, according to the secondary measuring function selected.

4.15.2 When the null function is selected the contents of the NULL store can be displayed and, if required, changed using the same procedures as those described for the RATIO store. This allows the difference between the measured value and an operator set value to be displayed. The keyboard address of the NULL store is

/NULL/

Note that, if the instrument leaves and re-enters the null measurement function, the value in the NULL store will be over-written with the measured value current when the mode is re-entered.

4.16 dB MEASUREMENTS

4.16.1 With the dB function selected the instrument computes

$$20 \log \frac{\text{measured volts}}{\text{voltage value in dB store}}$$

The calculation does not involve the resistance value held in the Ω store. However, if the voltage value in the dB store and the resistance value in the Ω store represent a power of 1 mW, the display units annunciator will indicate dBm. To select the dB function, press

/dB/.

The dB indicator will light. The measured voltage used in the computation may be r.m.s., mean, +peak or -peak, according to the secondary measuring function selected.

4.16.2 When the instrument is first switched on the dB store will be loaded with 774.6 mV. The value in the store can be displayed and, if necessary, changed using the same procedures as those described for the RATIO store. The keyboard address of the dB store is

/dB/.

4.17 ANALOGUE DISPLAY

4.17.1 The analogue display will be found to be particularly useful for obtaining peak or trough indications but may be used with all the measurement functions. The display is switched on and off by successive operations of

/METER/.

The coarse part of the display is automatically switched on when the manual ranging mode is selected. To obtain the full display press

/METER//METER/.

4.18 CALIBRATION TO AN EXTERNAL SIGNAL

4.18.1 To set the instrument display to a reference level the following procedure should be used:

(a) Connect the external source to the 5002 and select the required primary and secondary measurement functions. The instrument will measure and display the selected parameter of the input signal.

(b) Use the numeric keys to enter the level which the 5002 is required to display in respect of the signal being measured.

(c) Press /STORE//SHIFT//RATIO//SHIFT//RATIO/.

This will store the keyed-in reference level in the RATIO store, and return the instrument to the measurement mode with the ratio function selected. The display will indicate the ratio between the measured value of the signal from the external source and the reference level, held in the RATIO store.

(d) Press /STORE//CAL FACTOR/.

This will store the ratio appearing on the display for use as a calibration factor. The instrument will return to the measurement mode, with the ratio function selected, when the storage of the calibration factor is completed.

(e) Press /CAL FACTOR/.

The CAL FACTOR indicator will light and the calibration factor will be enabled. The display will now read 1.000, as the measured voltage is scaled to equal the reference value in the RATIO store.

4.18.2 Measurements may now be made on other signal sources using alternative primary, secondary and computed measurement functions. When the calibration factor is enabled the measured voltage is scaled before the calculation of computed function values. The factor is enabled and disabled by successive operations of

/CAL FACTOR/.

4.19 STORAGE OF FRONT PANEL SETTINGS

4.19.1 Up to 12 complete sets of front panel settings may be stored for later recall. The settings stored are:

(a) Primary measurement function.

(b) Secondary measurement function.

(c) Computed measurement function.

(d) Ranging mode.

(e) Measurement range.

(f) Calibration factor.

(g) Calibration factor enablement.

(h) Contents of Ω, RATIO, %, NULL, dB and AVERAGE stores.

(j) Form of input coupling selected.

(k) Input filter switching.

(l) Enablement of one special function.

Each set of front panel settings should be allocated a numeric address in the range 01 to 12. To store the front panel settings, press

/STORE//ALLOCATED NUMBER/.

Note that the leading zero must be entered for addresses 01 to 09. The STORE indicator will light when the key is pressed. It will be extinguished, and the instrument will return to the measurement mode with panel settings unchanged, when storage is completed.

4.19.2 The front panel settings can be recalled by pressing

/RECALL//ALLOCATED NUMBER/.

The RECALL indicator will light when the key is pressed. It will be extinguished, and the instrument will return to the measurement mode with the recalled front panel settings, when the recall is complete. The pressing of

/RECALL//0//0/

will recall the switch-on state (initialisation) settings. The stored

front panel settings are not lost on recall, so that stored patterns may be recalled as often as required. Individual settings in the stored pattern cannot be amended, so changes must be made by over-writing the stored pattern with a complete, revised pattern.

4.19.3 When the power to the instrument is switched off the front panel settings are automatically stored. They can be recalled immediately after switching on again by pressing

/RECALL//9//9/.

The first change of front panel settings after switching on over-writes the data stored in location 99. The facility of recalling the settings in use when the instrument was switched off is then lost.

4.20 SPECIAL FUNCTIONS

4.20.1 A number of special functions are available to the operator. These are listed in Table 4.1, and are called by pressing

/X//X//.//X//SHIFT//SF/.

where X X.X is the special function number

4.20.2 Only one special function may be used at a time. The entry of a second special function number will automatically cancel any special function previously selected. To display the number of the special function selected press

/RECALL//SHIFT//SF/.

4.20.3 All the special functions can be cancelled by pressing

/0//SHIFT//SF/.

In addition, special functions having numbers 50.1 and below can be cancelled by pressing any primary or secondary function key. This provides an easy method of reversion to the normal measurement mode, as, for example, when a special function is used to check the crest factor of a signal during a sequence of other measurements.

4.20.4 Special functions 60.1, 70.1 and 70.2 are not cancelled by the operation of the primary and secondary function keys. This allows the continuous average mode or one of the special peak measurement modes to be retained when changes to the secondary measurement function are made.

TABLE 4.1

Special Functions

Special Function Number	Function
0	Cancels all special functions.
10.1	Enables crest factor (highest peak/r.m.s)
10.2	Enables crest factor (positive peak/r.m.s)
10.3	Enables crest factor (negative peak/r.m.s)
20.1	Enables form factor (r.m.s/rectified mean)
30.1	Enables mean scaled to r.m.s (mean x 1.111)
40.1	Enables peak-to-peak.
50.1	Enables AC + DC rectified mean
60.1	Enables continuous average mode
70.1	Enables averaged peak measurement
70.2	Enables peak hold measurement
80.0	Enables Or and Ur error indications
80.1	Disables Or and Ur error indications
81.0	Recalls software issue number. NOTE: (1) To return to the measurement mode, press /CONTINUE/. (2) The software issue number is displayed in the format XY.Z. The number XY is the last two digits of the Racal-Dana part number of one of the ROMs fitted, and identifies the hardware compatible set in use. The number Z is the issue number. (Early model instruments display the number Z only).

NOTE: Special functions with numbers 50.1 and below may be cancelled by operation of any primary or secondary measurement function key.

4.21 ERROR CODES

4.21.1 The instrument is able to detect a number of error states, some of which are indicated on the display. The meanings of the error codes are given in Table 4.2.

4.21.2 The error codes relating to over-range and under-range inputs depend upon the signal output levels from the detectors, not on the value displayed. For example, if the ratio function is being used to display the ratio of a r.m.s value to a stored value, an error code will be generated if the r.m.s detector output is out of range, although the display may still be capable of showing the computed ratio.

4.21.3 The circumstances under which the over-range and under-range error codes are generated are as follows:

(a) Error 03 - Or

AC + DC coupling, and either
DC detector output and selected AC detector output over range, or
special function 50.1 in use and overall mean over range.

(b) Error 04 - AC Or

AC + DC or AC coupling, and
selected AC detector output only over range.

(c) Error 05 - DC Or

AC + DC coupling, and
DC detector output only over range.

(d) Error 06 - P HI

AC or AC + DC coupling, and
non-selected peak detector output over range.

(e) Error 07 - Ur

AC or AC + DC coupling, and either
selected measurement detector output under range, or
special function 50.1 in use and overall mean under range.

This error code may also occur when the auto-ranging mode is in use, the selected AC detector output is under range, and one peak detector is at a level which will become over range if the instrument down ranges. Under these circumstances down ranging is inhibited.

NOTE: When special functions are used to measure crest factor or form factor the under-range and over-range error codes will be generated as though r.m.s. measurement were selected.

4.21.4 The under-range and over-range error codes are generated if the input signal is less than 31.6% or more than 114.9% of the full scale value of the range in use.

TABLE 4.2

Error Codes

Error	Error Code
Non-volatile memory corrupted	01
Input close to destructive overload level	02
AC and DC inputs over range	03
AC input over range	04
DC input over range	05
AC peak excessive for range selected	06
Input under range	07
Computed result to be displayed exceeds display capacity	11
Invalid entry	12
Attempt made to store zero	13
GPIB syntax error	18
RAM failure	20
ROM failure, IC16 on 19-1024	23
ROM failure, IC17 on 19-1024	24
ROM failure, IC18 on 19-1024	25
ROM failure, IC19 on 19-1024	26

NOTE: (1) Error 02 is displayed as OUCH

Error 03 is displayed as Or

Error 04 is displayed as AC Or

Error 05 is displayed as dC Or

Error 06 is displayed as P HI

Error 07 is displayed as Ur

Error 18 is not displayed

Error 20 is indicated by switching on all LED elements of the display

The remaining errors are displayed as Er followed by the two digit error code.

(2) The display of error codes other than Er 01 and OUCH can be inhibited by setting switch 3 of switch bank S30 on assembly 19-1024 to the closed position (where the slider is moved in the direction of the arrow moulded on it or towards the switch section number).

4.22 CONTROL VIA THE GPIB

4.22.1 The 5002 can be operated via the GPIB in either the addressed mode or the talk only mode. In the former the instrument makes measurements in response to commands, prefaced by the instrument's listen address, sent via the bus by the controller. The last measured value is loaded onto the bus when the instrument is addressed to talk.

4.22.2 In the talk only mode the 5002 will take measurements continually, at a rate determined by the averaging time in use, in accordance with instructions entered using the front panel controls. At the end of each measurement cycle the measured value is entered into a buffer store, from where it is loaded onto the bus in response to a signal on the NRFD line (commencement of the handshake sequence). If a measurement cycle is completed while data transfer is in progress, the updating of the buffer store is delayed until the data transfer is completed.

4.23 REMOTE/LOCAL CHANGEOVER

4.23.1 LOCAL TO REMOTE CONTROL CHANGEOVER

4.23.1.1 The 5002 is switched from local to remote control by the following sequence of control and data line messages:

(a) Remote enable (REN) true (low).	This primes the remote control enable, but the 5002 remains in local control. REN must remain true if any instrument on the bus is to remain in remote control.
(b) Attention (ATN) true (low)	
(c) Listen address	The 5002 enters the listener addressed state (LADS) on recognition of its listen address.
(d) ATN false (high)	The 5002 enters the listener active state (LACS) after a delay, and enters the remote state (REMS) on receipt of the first data byte.

4.23.1.2 No change to any of the 5002 control settings occurs on changeover from local to remote control.

4.23.2 REMOTE TO LOCAL CONTROL CHANGEOVER

4.23.2.1 The 5002 will be switched from remote to local control on:

(a) Operation of the front panel LOCAL key. This is effective only if local lockout is not set.

(b) Receiving the go to local (GTL) command when in the LADS.

(c) Receiving the REN message false (high). This is independent of the addressed state of the 5002.

4.23.2.2 No change to any of the 5002 control settings occurs on changeover from remote to local control.

4.23.3 LOCAL LOCKOUT (LLO)

4.23.3.1 Operation of the front panel LOCAL key during the transfer of data to the 5002 could result in the instrument being switched from remote to local control with the control settings in an unknown state. To prevent this the LOCAL key can be disabled by setting local lockout.

4.23.3.2 Local lockout may be set at any time when the REN message is true (low). The recognition of the LLO message is not dependent on the addressed state of the instrument. Apart from the disablement of the LOCAL key it causes no changes to the operation of the 5002. The only method of cancelling LLO is to send the REN message false (high). This affects all instruments on the bus, putting them to the local control state (LOCS).

4.24 COMMAND CODES FOR ADDRESSED MODE OPERATION

4.24.1 Once the 5002 has been addressed the instrument functions can be set by means of device dependent commands, consisting of pairs of alpha and numeric characters, as listed in Tables 4.4 to 4.18. If more than one command is to be sent no delimiter is required. The end of message may be signalled by sending any of the terminating groups shown in Table 4.3. The changes in 5002 operation are implemented at the end of the message.

TABLE 4.3

Permitted Terminating Groups

1	2	3	4	5
CR EOI true	LF	CR,LF	CR,LF EOI true	LF EOI true

TABLE 4.4

Primary Measurement Function Commands

Function	Code
Volts	FØ
Watts	F1

TABLE 4.5

Ω Store Commands

Function	Code
Store contents of numerical input buffer in Ω store.	Q1
Load contents of the Ω store into the output buffer.	Q2

NOTE: After loading the contents of a store into the output buffer the 5002 must be put to the talker active state for the data to be put onto the bus. The instrument will return to the measurement mode once the output buffer is loaded, but failure to read the buffer contents will prevent measurement data being entered.

TABLE 4.6

Secondary Measurement Function Commands

Function	Code
RMS	DØ
Mean	D1
+Peak	D2
-Peak	D3

TABLE 4.7

Compute Function Commands

Function	Code
Select RATIO	G1
Store the contents of the numerical input buffer in the RATIO store. If the numerical input buffer is empty, store the last measured value.	G2
Load the RATIO store contents into the output buffer.	G3
Select dB	L1
Store the contents of the numerical input buffer in the dB store. If the numerical input buffer is empty, store the last measured value.	L2
Load the dB store contents into the output buffer.	L3
Select NULL	N1
Store the contents of the numerical input buffer in the NULL store. If the numerical input buffer is empty store the last measured value.	N2
Load the NULL store contents into the output buffer.	N3
Select %	P1
Store the contents of the numerical input buffer in the % store. If the numerical input buffer is empty, store the last measured value.	P2
Load the % store contents into the output buffer.	P3

NOTE: (1) Selection of one compute function will automatically cancel any other compute function. Cancellation code CØ allows cancellation of all computed functions.

(2) The numerical input buffer is cleared, if required, by means of cancellation code C1.

(3) After loading the contents of a store into the output buffer the 5002 must be put to the talker active state for the data to be put onto the bus. The instrument will return to the measurement mode once the output buffer is loaded, but failure to read the buffer contents will prevent measurement data being entered.

TABLE 4.8

Range Commands

Range	Code
Autorange	RØØ
100 µV	RØ1
300 µV	RØ2
1 mV	RØ3
3 mV	RØ4
10 mV	RØ5
30 mV	RØ6
100 mV	RØ7
300 mV	RØ8
1 V	RØ9
3 V	R10
10 V	R11
30 V	R12
100 V	R13
300 V	R14
Manual Range	RM
Load the output buffer with the full scale value of the range in use	RZ

NOTE: (1) The use of code RM will take the instrument from the autorange mode to the manual range mode without changing the range in use.

(2) After loading the contents of a store into the output buffer the 5002 must be put to the talker active state for the data to be put onto the bus. The instrument will return to the measurement mode once the output buffer is loaded, but failure to read the buffer contents will prevent measurement data being entered.

TABLE 4.9

Input Coupling Commands

Input Coupling	Code
AC	HØ
AC + DC	H1

TABLE 4.10

Control Setting Storage Commands

Function	Code
Store current control settings and store values in stores numbered 01 to 12	AØ1 to A12

NOTE: Storage location ØØ always contains the values set when the instrument is first switched on, and cannot be overwritten.

TABLE 4.11

Control Setting Recall Commands

Function	Code
Recall and set initial control settings	BØØ
Recall and set control settings from stores numbered 01 to 12	BØ1 to B12
Recall control settings in use when instrument was last switched off	B99

NOTE: (1) The data stored in location 99 is overwritten as each change of instrument setting is made. The facility for recalling the settings in use when the instrument was switched off is only available immediately after switching on.

(2) Either the Device Clear (DCL) or the Selective Device Clear (SDC) command may be used instead of BØØ.

TABLE 4.12

Calibration Factor Commands

Function	Code
Disable calibration factor	UØ
Enable calibration factor	U1
Store contents of numerical input buffer in calibration factor store	U2
Load contents of calibration factor store into the output buffer	U3

NOTE: After loading the contents of a store into the output buffer the 5002 must be put to the talker active state for the data to be put onto the bus. The instrument will return to the measurement mode once the output buffer is loaded, but failure to read the buffer contents will prevent measurement data being entered.

TABLE 4.13

Interrupt Commands

Function	Code
No service requests generated	IØ
Service request generated when measured value is available	I1
Service request generated when error is detected	I2
Service request generated when measured value is available or when error is detected	I3
Load error code number into output buffer	I4

NOTE: (1) After loading the error number into the output buffer the 5002 must be put to the talker active state for the data to be put onto the bus. The instrument will return to the measurement mode once the output buffer is loaded, but failure to read the buffer contents will prevent measurement data being entered.

(2) The loading of the error code into the output buffer does not cancel the error code. Error codes other than 01, 20, 23, 24, 25 and 26 are cancelled using the cancellation code C2.

TABLE 4.14

Measurement Averaging Mode and Timing Selection Commands

Function	Code
Select fixed averaging mode	SØ
Select continuous averaging mode	S1
Select true peak measurement	S2
Select averaged peak measurement	S3
Select peak hold measurement	S4
Store contents of numerical input buffer in the AVERAGE store	S5
Load contents of AVERAGE store into the output buffer	S6
Store contents of numerical input buffer in the TRIGGER DELAY store	S7
Load contents of the TRIGGER DELAY store into the output buffer	S8

NOTE: After loading the contents of a store into the output buffer the 5002 must be put to the talker active state for the data to be put onto the bus. The instrument will return to the measurement mode once the output buffer is loaded, but failure to read the buffer contents will prevent measurement data being entered.

TABLE 4.15

Input Filter Commands

Function	Code
Filter out	JØ
Filter in	J1

TABLE 4.16

Trigger Commands

Function	Code
Perform continuous measurement cycles, updating the output buffer at the end of each cycle	TØ
Leave the continuous measurement mode and enter the triggered measurement mode	T1
If in the triggered measurement mode, perform one measurement and update the output buffer	T2
If in the triggered measurement mode, perform one measurement after a delay, equal to the value in the trigger delay store, and update the output buffer	T3

NOTE: (1) After a change of range a three second delay, additional to that held in the trigger delay store, is automatically inserted after the trigger command.

(2) The Group Execute Trigger (GET) command may be used instead of code T2 using the following procedure:

a) Send command T1.

b) Send command T2. The 5002 will perform one measurement cycle.

c) Send the GET command each time a further measurement cycle is required. Note that when using the GET command, the 5002 must be put to the talker active state after each measurement cycle.

(3) The use of the GET command after code TØ has been used will terminate the current measurement cycle. A new cycle will begin immediately.

(4) The instrument will revert to continuous measurement if the continuous averaging mode is selected (see Table 4.14). If the continuous averaging mode is cancelled the instrument will return to the last trigger mode enabled.

TABLE 4.17

Cancellation Commands

Function	Code
Cancel compute functions	CØ
Clear numerical input buffer	C1
Clear error code	C2

NOTE: Code C2 will not cancel error codes 01, 20, 23, 24, 25 or 26.

TABLE 4.18

Special Function Commands

Special Function Number	Function	Code
0	Cancel special function	YØ
10.1	Crest factor (highest peak/r.m.s.)	Y1
10.2	Crest factor (positive peak/r.m.s.)	Y2
10.3	Crest factor (negative peak/r.m.s.)	Y3
20.1	Form factor (r.m.s./rectified mean)	Y4
30.1	Mean scaled to r.m.s. (mean x 1.111)	Y5
40.1	Peak-to-peak	Y6
50.1	AC+DC rectified mean	Y7
60.1	Continuous average mode	S1
70.0	True peak measurement	S2
70.1	Averaged peak measurement	S3
70.2	Peak hold measurement	S4
/RECALL//SF/	Load the number held in the SPECIAL FUNCTION store into the output buffer	Y8

NOTE: After loading the contents of a store into the output buffer the 5002 must be put to the talker active state for the data to be put onto the bus. The instrument will return to the measurement mode once the output buffer is loaded, but failure to read the buffer contents will prevent measurement data being entered.

4.25 ENTRY OF NUMERICAL VALUES

4.25.1 The format for numbers to be entered in the numerical input buffer for subsequent loading into the internal stores is given in Table 4.19.

TABLE 4.19

Numerical Input Format

Byte	Interpretation	Permitted ASCII Characters
1	Sign of mantissa	Space, + or -
2 3 4 5 6	Most significant digit Digit/decimal point Digit/decimal point Digit/decimal point Least significant digit	Up to four digits, with a decimal point if required, may be entered. Unused bytes need not be filled. Excess spaces are ignored.
7	Exponent indicator	E or e
8	Sign of exponent	Space, + or -
9	Exponent digit	Ø to 9

NOTE: (1) An unsigned mantissa or exponent is assumed positive. Bytes 1 and/or 8 may be omitted when the sign is positive.

(2) The string may be terminated with CR, LF or by the first byte of the succeeding command.

(3) If the exponent group is not required bytes 7 to 9 may be omitted.

(4) The exponent group replaces the units keys used when entering values in local control. The units assumed by the numbers held in store are given in Table 4.20.

TABLE 4.20

Stored Value Units

Store	Units	
	VOLTS Mode	WATTS Mode
Ohms	Ω	Ω
Ratio	Volts	Watts
%	Volts	Watts
Null	Volts	Watts
dB	Volts	Watts
Average	Seconds	Seconds
Time Out	Seconds	Seconds
Calibration Factor	Number	Number

4.26 OUTPUT MESSAGE FORMAT

4.26.1 The same output message format is used for the transmission of measured values, error code numbers or the values held in the instrument's internal stores. The message consists of a string of 12 ASCII characters for each value transmitted. These are to be interpreted as shown in Table 4.21. No parity check is included. Each byte is accompanied by the full handshake procedure on the NRFD, DAV and NDAC control lines.

TABLE 4.21

Interface Output Message Format

Byte No	Interpretation	Permitted ASCII Characters
1	Sign of measurement	+ or -
2	Most significant digit	0 to 9
3	Decimal point	.
4	Digit	0 to 9
5	Digit	0 to 9
6	Least significant digit	0 to 9
7	Exponent indicator	E
8	Sign of exponent	+ or -
9	More significant digit	0 to 9
10	Less significant digit	0 to 9
11	Carriage return	CR
12	Line Feed	LF

4.27 STATUS BYTE FORMAT

4.27.1 The data line usage for the status byte, generated in response to a serial poll, is given in Table 4.22.

TABLE 4.22

Status Byte

DIO Line	Function
1	Not used
2	Not used
3	Not used
4	Not used
5	'1' indicates that the instrument is busy
6	'1' indicates that an error has been detected
7	'1' indicates that service was requested
8	Not used

NOTE: The status byte does not provide information about the nature of any error which has been detected. The addressed command I4 can be used to have the error number loaded into the output buffer. This will then be transmitted via the bus when the instrument is addressed to talk.

4.28 SERVICE REQUEST (SRQ) OUTPUT

4.28.1 The instrument can be instructed via the bus to generate an SRQ output as follows.

(a) SRQ generation inhibited

(b) SRQ sent true when data are available

(c) SRQ sent true when an error is detected

(d) SRQ sent true when data are available or when an error is detected.

The codes used are given in Table 4.13.

4.28.2 When the 5002 is being used in the triggered mode a delay, equal to the value set in the AVERAGE store, will occur between the generation of the SRQ output and the appearance of the SRQ annunciator on the front panel.

4.29 LOGIC LEVELS

4.29.1 The control, handshake and data lines operate at standard +5 V TTL levels. Negative logic is used, i.e. logic '1' is represented by a level $\leqslant$0.8 V and logic '0' by a level $\geqslant$2 V.

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REPAIR REQUEST FORM

To allow us to better understand your repair requests, we suggest you use the following outline and include a copy with your instrument to be sent to your local Racal-Dana repair facility.

Model Number _____ Options _____ Date _____

Serial Number _____ P. O.# _____

Company Name _____

Address _____

City _____ State _____ Zip Code _____

Contact _____ Phone Number _____

1. Describe, in detail, the problem and symptoms you are having.

_____

_____

2. If you are using your unit on the bus, please list the program strings used and the controller type, if possible.

_____

_____

3. List all input levels, and frequencies this failure occurs.

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4. Indicate any repair work previously performed.

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5. Please give any additional information you feel would be beneficial in facilitating a faster repair time. (I. E., modifications, etc.)

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MP MASTER
MA30571